(1) SAMPLING (USING MATLAB)
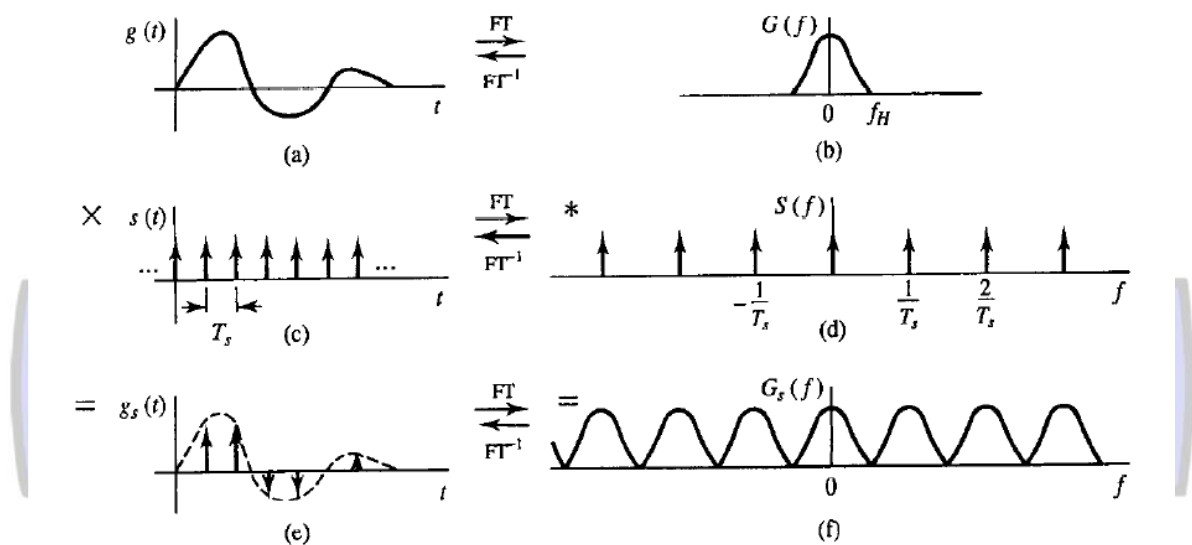
1. OBJECTIVES

Experiment the theory of sampling in Matlab.

2. FUNDAMENTALS

Ideal sampling is accomplished by multiplying the baseband signal $g(t)$ by the impulse signal $s(t)$. The result sampled version is $g_s(t) = g(t) \cdot s(t)$

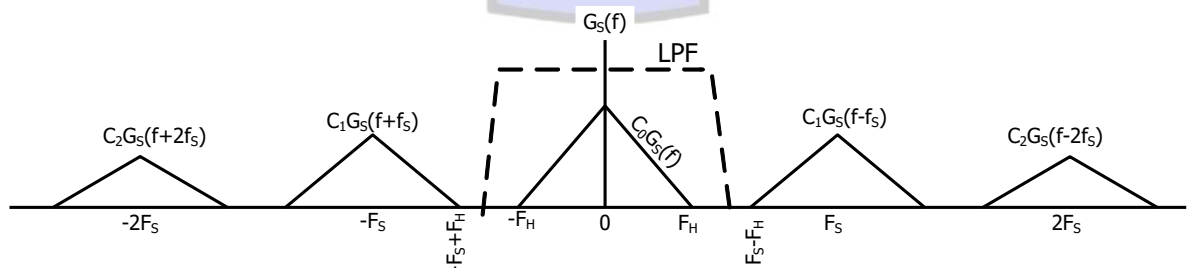The following figures illustrate the sampling in both time and Fourier domains.

3. RECONSTRUCTION

Correct sampling must comply with the Nyquist criterion:

$$f_s \geq 2f_H \tag{1-1}$$

to prevent the aliasing at the reconstruction. The original signal is restored by applying the samples to a LPF.

4. PROCEDURE

Run the following Matlab code, and

- examine different values for f_m and f_s

- print two cases for proper sampling

- show a case where there is an aliasing at the output.

- suggest two methods to solve the aliasing

```matlab
fm =   1; % bandwidth of baseband signal
fs =  10; % Hz  number of samples or Sampling Freq


Sig = @(t) 1.2*sin(2*pi*fm*t);


t=linspace(0,1,1000);
subplot(3,1,1)
plot(t,Sig(t))
Axx=[0 1 1.2*min(Sig(t)) 1.2*max(Sig(t))];
axis(Axx);ylabel('g(t)');xlabel('\itt (sec)');grid on;
title(sprintf('Baseband Signal (f_m=%gHz)',fm))


sam   = ones(1,fs);
t_s = linspace(0,1,fs);


subplot(3,1,2)
stem(t_s,sam,'filled','MarkerSize',5)
axis([0 1 -0.2 1.2]);ylabel('s(t)');xlabel('\itt (sec)');
title(sprintf('Sampling Signal (f_s=%gHz)',fs))


subplot(3,1,3)
stem(t_s,Sig(t_s),'filled','MarkerSize',5)
axis(Axx);ylabel('g_s(t)');xlabel('\itt (sec)');title('Sampled Signal')
```
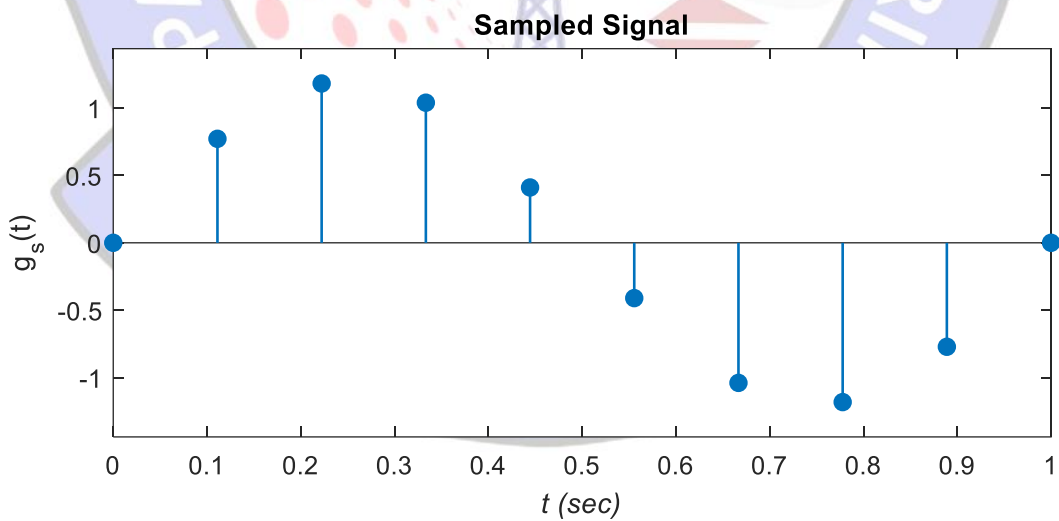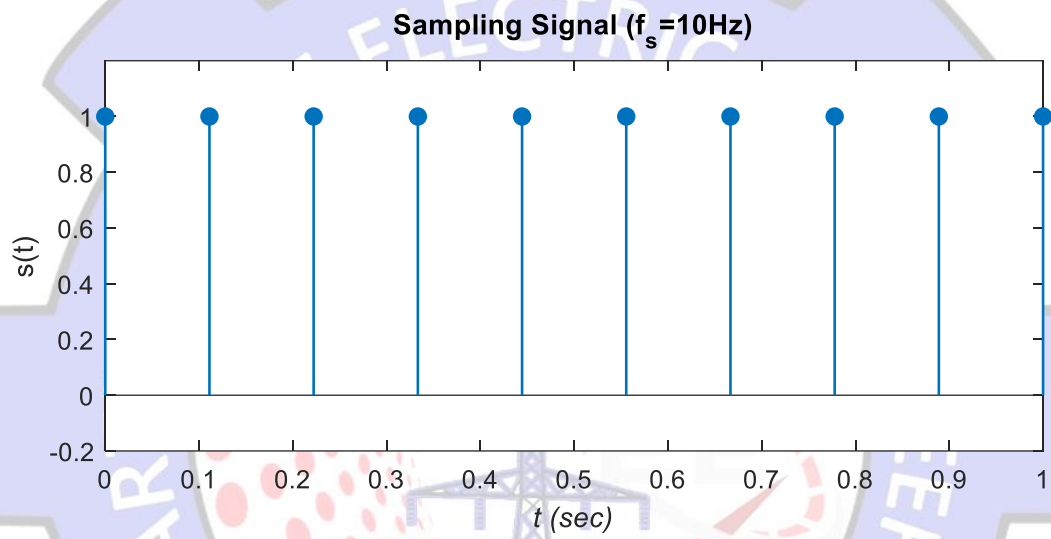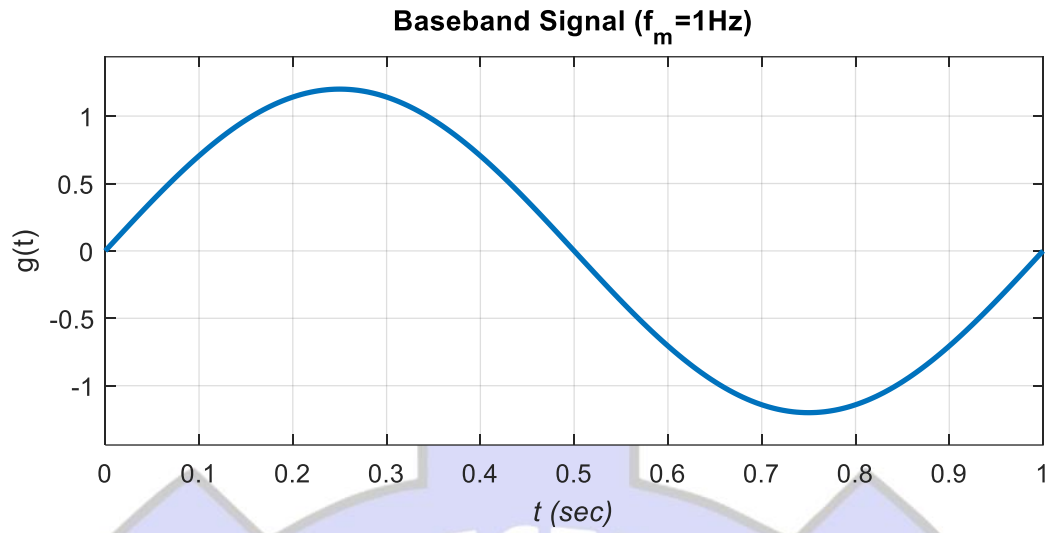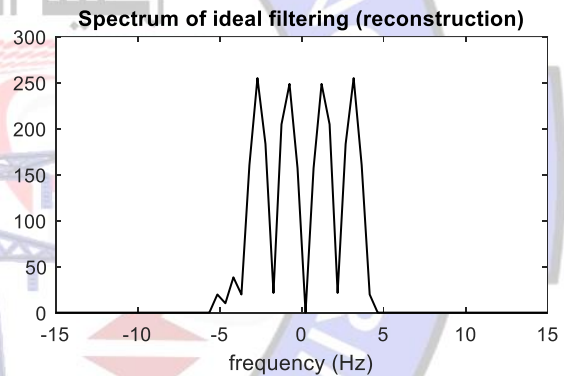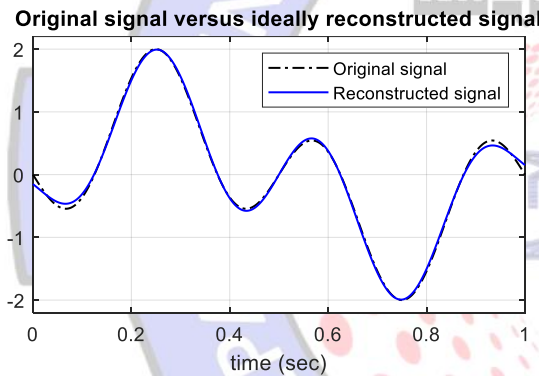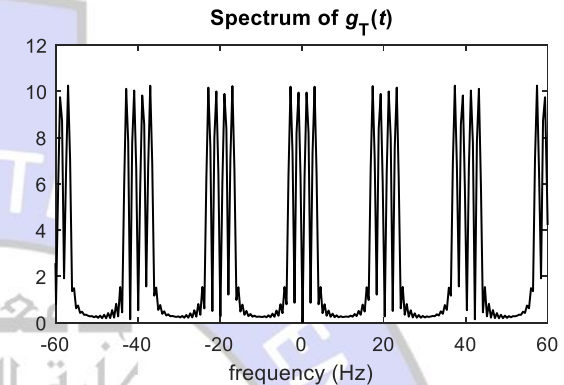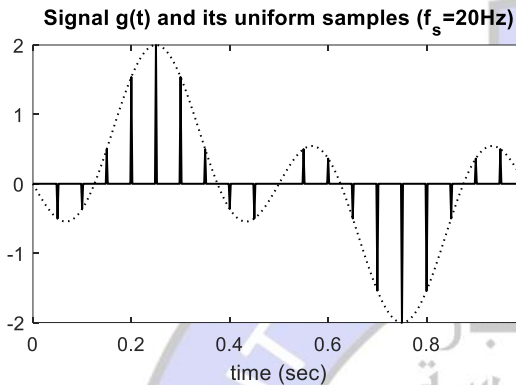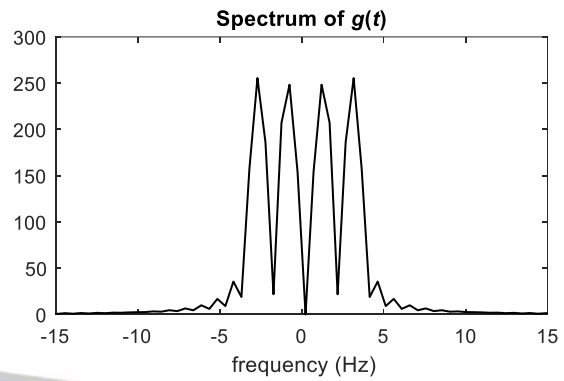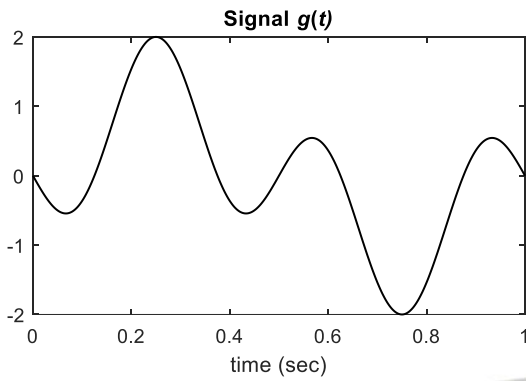
Baseband Signal (f_m=1Hz)

Sampling Signal (f_s=10Hz)

Sampled Signal

Signal g(t)

Spectrum of g(t)

Signal g(t) and its uniform samples (f$_s$=20Hz)

Spectrum of g$_T$(t)

Original signal versus ideally reconstructed signal

Spectrum of ideal filtering (reconstruction)

5. HOMEWORK

Design and implement a sampling circuit using Multisim. Also, implement the corresponding reconstruction circuit using LPF. Display both the input and the output signals in the time domain at different values for the sampling frequency. Show the Aliasing in the time domain.